

- 63 -

What is claimed is:

1. A device for detecting near field electromagnetic signals, comprising a strip array antenna, wherein the strip array antenna includes:  
a plurality of conductors being arranged so a long axis of each is in parallel and spaced from each other, each of the plurality of conductors having a length,  
a plurality of reactive tuning components, at least one of said plurality of reactive tuning components being electrically coupled to each conductor and to one of ground or virtual ground, and  
wherein the length of each conductor and a value of each reactive tuning component are set so an apparent electrical length of each conductor is equal to be about  $n\lambda/4$ , where  $n$  is an integer  $\geq 1$  and  $\lambda$  is the wavelength of the signal to be detected.
2. The detection device of claim 1, wherein the length of each of the plurality of conductors is further selected so as optimize SNR of the near-field electromagnetic signals detected from a desired region of interest.
3. The detection device of claim 2, wherein the length  $L$  of each conductor, is further chosen for the detection of signals at distances or depths  $d$  from the detector such that  $0.5d \leq L \leq 5d$ .
4. The detection device of claim 1, wherein the reactive tuning component is a capacitor.
5. The detection device of claim 1, wherein the near-field electromagnetic signals are magnetic resonance (MR) signals from a region of interest in a sample undergoing MR evaluation.
6. The detection device of claim 1, wherein the conductors are configured and arranged so as to form one of a planar strip array, a curved strip array, flexible strip array or a cylindrical strip array.

- 64 -

7. The detection device of claim 6 wherein said ground for a cylindrical strip array includes a plurality of ground plane members with one ground plane member for each conductor, and wherein the spaces between at least two of the said plurality of ground plane members and their corresponding conductors is left open to provide space for air, and/or permit viewing through the detection device.

8. The detection device of claim 6, wherein said ground for a cylindrical strip array includes a plurality of ground plane members with one ground plane member for each conductor, and wherein a transparent substrate is disposed between each conductor and its corresponding ground plane member to permit viewing through the detection device in the space between adjacent conducting members.

9. The detection device of claim 6, wherein the plurality of conductors of the cylindrical strip array are arranged so as to extend along the cylindrical axis thereof.

10. The detection device of claim 6, wherein the plurality of conductors of the cylindrical strip array are arranged so that each conductor extends circumferentially.

11. The detection device of claim 10, wherein each circumferentially extending conductor is arranged so as to form a continuous loop.

12. The detection device of claim 11, wherein each circumferential continuous loop includes match and tune circuitry to couple signals detected in each loop out of each loop.

13. The detection device of claim 10, wherein each circumferential continuous loop includes circuitry to deactivate the loop during magnetic resonance excitation.

- 65 -

14. The detection device of claim 1, further comprising a plurality of reactive coupling elements, where at least one of the plurality of reactive coupling components is electrically connected between and to adjacent conductors.

15. The detection device of claim 14, wherein a value of each of said plurality of reactive coupling elements is set so as to substantially reduce coupling of a signal in one of said plurality of conductors to an adjacent conductor(s).

16. The detection device of claim 14, wherein each of said plurality of reactive coupling elements is a capacitor.

17. The detection device of claim 1, wherein:

said one of ground or virtual ground is formed by one of a ground plane or a plurality of ground plane members, one ground plane member for each of said plurality of conductors, said ground plane and said plurality of ground plane members being at one of ground or virtual ground; and

said at least one of said plurality of reactive tuning components is electrically coupled to each conductor and to one of the ground plane or the ground plane member that corresponds to said each conductor.

18. The detection device of claim 17, wherein spaces between at least two of said plurality of ground plane members that comprise said one of ground or virtual ground and their corresponding conductors is left open to provide space for air, and/or permit viewing through the detection device.

19. The detection device of claim 1, wherein a plurality of reactive tuning components are electrically coupled between and to each conductor and the one of ground or virtual ground.

- 66 -

20. The detection device of claim 17, further comprising:  
a substrate arranged so as to be disposed between the ground plane that comprises said one of ground and virtual ground and the plurality of conductors.

21. The detection device of claim 17, further comprising:  
a plurality of substrate members arranged so one of said plurality of substrate members is disposed between each conductor and said one of the ground plane or the ground plane member that corresponds to said each conductor.

22. The detection device of claim 1, further comprising an encapsulation member, wherein the encapsulation member includes:  
a substrate, upon one surface of which is disposed the plurality of conductors,  
a ground plane that is disposed on an opposing surface of the substrate, said ground plane forming said one of ground or virtual ground,  
an overlay that covers the conductors disposed on the substrate; and  
wherein the plurality of reactive tuning components are electrically coupled to the ground plane such that said at least one of said plurality of reactive tuning components is electrically connected between each conductor and the ground plane.

23. The detection device of claim 1, further comprising an encapsulation member, wherein the encapsulation member includes:  
a substrate, upon one surface of which is disposed the plurality of conductors,  
a plurality of ground plane members that are disposed on an opposing surface of the substrate, each of said plurality of ground plane members forming said one of ground or virtual ground,  
an overlay that covers the conductors disposed on the substrate; and

- 67 -

wherein said at least one of said plurality of reactive tuning components is electrically connected between each conductor and the ground plane member that corresponds to said each conductor.

24. The detection device of claim 1, wherein the spacing of each conductor is set so as to provide sensitive detection of signals across the plurality of conductors perpendicular to the plurality of conductors, and to substantially reduce coupling of a signal in one of the plurality of conductors to an adjacent conductor(s).

25. The detection device of claim 24, wherein the spacing  $s$  of each conductor, is further chosen to fall in a range  $L/10 \leq s \leq 2L$ , where  $L$  is the length of each of said plurality of conductors.

26. The detection device of claim 1, wherein  $n$  is an odd integer and wherein said detection device further comprises a termination mechanism operably connected to one end of each conductor and configured so as to terminate each of said one end as one of a short circuit or an open circuit

27. The detection device of claim 26, wherein the termination mechanism is configured so said one end of the plurality of conductors is alternately terminated as the short circuit and the open circuit.

28. The detection device of claim 21, wherein:  
each conductor includes a first end and a second end;  
the first end of each odd numbered conductor of the strip array antenna is terminated as one of the short circuit or the open circuit;  
the second end of each even numbered conductor of the strip array antenna is terminated as one of the short circuit or the open circuit.

29. The detection device of claim 28, wherein all first ends are terminated as one of the short circuit or the open circuit and all second ends are terminated as the other of the short circuit or the open circuit.

- 68 -

30. The detection device of claim 1, wherein one end of each conductor is terminated with a resistive match and wherein  $n$  is an even integer.

31. The detection device of claim 30, wherein the resistive match is formed from reactive circuit elements.

32. The detection device of claim 1, further comprising an electromagnetic guard mechanism being arranged so that the guard mechanism significantly isolates at least a portion of the strip array antenna from electromagnetic interference from signals derived from outside the sensitive region of the detector.

33. The detection device of claim 32, wherein the guard mechanism comprises a plurality of guard elements, and wherein the plurality of guard elements are arranged such that one of said plurality of guard elements is disposed in proximity to each end of the strip array antenna to significantly isolate ends of the strip array antenna.

34. The detection device of claim 33, wherein the plurality of guard elements are further arranged such that one of said plurality of guard elements is disposed along and in proximity to each side of the strip array antenna to isolate the sides and ends of the strip array antenna.

35. The detection device of claim 32, wherein the guard mechanism comprises a plurality of guard elements, and wherein the plurality of guard elements are arranged such that one of said plurality of guard elements is disposed in proximity to and along each side of the strip array antenna to isolate sides of the strip array antenna.

36. The detection device of claim 32, wherein the guard mechanism is electrically grounded.

37. The detection device of claim 32, wherein the near-field electromagnetic signals are magnetic resonance (MR) signals from a region of interest in a sample undergoing MR evaluation and wherein the guard mechanism includes circuitry configured and arranged to deactivate the guard mechanism during magnetic resonance excitation.

38. The detection device of claim 32, wherein:  
the conductors are configured and arranged so as to form a cylindrical strip array having a cylinder axis, and  
the guard mechanism comprises a plurality of guard elements, wherein the plurality of guard elements are arranged so one of the plurality of guard element is disposed in a plane that is essentially perpendicular to the cylinder axis and is one of in proximity to each end of the cylindrical strip array, when the conductors are arranged so as to be parallel to the cylinder axis or in proximity to each side of the cylindrical strip array when the conductors extend at least partially circumferentially about the cylinder axis.

39. The detection device of claim 38 wherein said guard elements that are disposed in said plane essentially perpendicular to the cylinder axis form circumferential loops.

40. The detection device of claim 38 wherein said plurality of guard elements further includes guard elements that are arranged so as to be parallel to the cylinder axis and are disposed in proximity to the first and last conductors, in the case when the conductors of the cylindrical strip array are arranged so as to be parallel to the cylinder axis and the conductors extend only partially circumferentially about the cylinder axis.

41. The detection device of claim 38, wherein the near-field electromagnetic signals are magnetic resonance (MR) signals from a region of interest in a sample undergoing MR evaluation and wherein the guard

- 70 -

mechanism includes circuitry configured and arranged to deactivate the guard mechanism during magnetic resonance excitation.

42. The detection device of claim 1, wherein a number of parallel conductors comprising the strip array antenna is one of 4 or more conductors, 16 or more conductors, 32 or more conductors, in the range of from 4 to 16 conductors, in the range of from 4 to 32 conductors, or in the range of from 16-32 conductors.

43. The detection device of claim 20, wherein the substrate is flexible.

44. The detection device of claim 1, wherein each of said plurality of conductors and said one of ground or virtual ground are formed from at least one of copper, silver, gold, a super-conducting material, or a material coated with one of copper, silver, gold, or a super-conducting material.

45. The detection device of claim 44, where each of said plurality of conductors and said one of ground or virtual ground are formed from one of a super-conducting material or a material coated with or a super-conducting material and wherein said strip array is configured and arranged so as to be is cryostatically encapsulated to maintain the super-conducting properties.

46. The detection device of claim 1, wherein one of said plurality of conductors, said one of ground or virtual ground or said plurality reactive tuning components is formed from a printed circuit board.

47. The detection device of claim 1 wherein:  
one end of each one of the plurality of conductors is connected to termination circuitry, and  
the other end of each one of the plurality of conductors is connected to matching and tuning means.



- 71 -

48. The detection device of claim 47 further including transmit/receive switching means connected to said matching and tuning means.

49. The detection device of claim 48 further including preamplifier means connected to said transmit/receive switching means.

50. The detection device of claim 49 further including receiver means connected to said preamplifier means.

51. The detection device of claim 1, wherein each of said plurality of conductors includes at least one conducting element having an element length and at least one inductive element electrically coupled thereto and wherein the element length, a value of each reactive tuning component and a value of each of said at least one inductive element are set so an apparent electrical length of each conductor is equal to be about  $n\lambda/4$ , where  $n$  is an integer  $\geq 1$  and  $\lambda$  is the wavelength of the signal to be detected.

52. A device for detecting near field electromagnetic signals, comprising a strip array antenna, wherein the strip array antenna includes:

a plurality of conductors arranged so a long axis of each is in parallel and spaced from each other, wherein each of said plurality of conductors includes at least one conducting element having an element length;

a plurality of inductive elements at least one inductive element being electrically coupled to said at least one conducting element of each of said plurality of conductors; and

wherein the element length of said at least one conducting element, and a value of said at least one inductive element electrically coupled thereto are set so an apparent electrical length of each of said plurality of conductors is equal to be about  $n\lambda/4$ , where  $n$  is an integer  $\geq 1$  and  $\lambda$  is the wavelength of the signal to be detected.

- 72 -

53. The detection device of claim 52, further comprising a plurality of reactive tuning components, at least one of said plurality of reactive tuning components being electrically coupled to said at least one conducting element and to one of ground or a ground plane such that said at least one of said plurality of reactive tuning components is electrically connected between said at least one conducting element of each of said plurality of conductors and said one of ground or virtual ground; and wherein the element length, a value of said at least one of said plurality of reactive tuning components and a value of each of said at least one inductive element for each of said plurality of conductors are set so an apparent electrical length of each of said plurality of conductors is equal to be about  $n\lambda/4$ , where  $n$  is an integer  $\geq 1$  and  $\lambda$  is the wavelength of the signal to be detected.

54. The detection device of claim 52, wherein:  
each of said plurality of conductors includes a plurality of conducting elements each having an element length;  
said at least one inductive element is electrically coupled between a pair of said plurality of conducting elements; and  
a total of the element length for said plurality of conducting elements and a value of each of said at least one inductive element for each of said plurality of conductors are set so an apparent electrical length of said each of said plurality of conductors is equal to be about  $n\lambda/4$ , where  $n$  is an integer  $\geq 1$  and  $\lambda$  is the wavelength of the signal to be detected.

55. The detection device of claim 54, further comprising a plurality of reactive tuning components, at least one of said plurality of reactive tuning components being electrically coupled to said at least one conducting element and to one of ground or a ground plane such that said at least one of said plurality of reactive tuning components is electrically connected between said at least one conducting element of each of said plurality of conductors and said one of ground or virtual ground; and

- 73 -

wherein a total of the element length for said plurality of conducting elements, a value of said at least one of said plurality of reactive tuning components and a value of each of said at least one inductive element for each of said plurality of conductors are set so an apparent electrical length of each of said plurality of conductors is equal to be about  $n\lambda/4$ , where  $n$  is an integer  $\geq 1$  and  $\lambda$  is the wavelength of the signal to be detected.

56. An NMR or MRI system comprising:  
a magnet,  
gradient magnetic field coil means  
gradient coil supply means,  
RF transmit means,  
gradient and RF control means,  
NMR receiver means, and  
a detection device that detects MR/ NMR signals from a region of interest in a sample undergoing NMR or MRI, said detection device comprising a strip array antenna that includes:  
a plurality of conductors being arranged so a long axis of each is in parallel and spaced from each other, each of the plurality of conductors having a length,  
a plurality of reactive tuning components, at least one of said plurality of reactive tuning components being electrically coupled to each conductor and to one of ground or virtual ground, and  
wherein the length of each conductor and a value of each reactive tuning component are set so an apparent electrical length of each conductor is equal to be about  $n\lambda/4$ , where  $n$  is an integer  $\geq 1$  and  $\lambda$  is the wavelength of the MR/ NMR signals to be detected.

57. The detection device of claim 56, wherein the length of each of the plurality of conductors is further selected so as optimize SNR of the MR/ NMR signals detected from the desired region of interest.

- 74 -

58. The system of claim 56 wherein at least the detection device is configured and arranged to detect hydrogen ( $^1\text{H}$ ) NMR signals.

59. The system of claim 56 wherein at least the detection device is configured and arranged to detect NMR signals from nuclei other than hydrogen.

60. An NMR or MRI system comprising:  
a magnet,  
gradient magnetic field coil means  
gradient coil supply means,  
RF transmit means,  
gradient and RF control means,  
NMR receiver means, and  
a detection device that detects MR/ NMR signals from a region of interest in a sample undergoing NMR or MRI, said detection device comprising a strip array antenna that includes:  
a plurality of conductors arranged so a long axis of each is in parallel and spaced from each other, wherein each of said plurality of conductors includes at least one conducting element having an element length,  
a plurality of inductive elements at least one inductive element being electrically coupled to said at least one conducting element of each of said plurality of conductors, and  
wherein the element length of said at least one conducting element, and a value of said at least one inductive element electrically coupled thereto are set so an apparent electrical length of each of said plurality of conductors is equal to be about  $n\lambda/4$ , where  $n$  is an integer  $\geq 1$  and  $\lambda$  is the wavelength of the signal to be detected.

- 75 -

61. The system of claim 59 wherein said strip array antenna further includes

a plurality of reactive tuning components, at least one of said plurality of reactive tuning components being electrically coupled to said at least one conducting element and to one of ground or a ground plane such that said at least one of said plurality of reactive tuning components is electrically connected between said at least one conducting element of each of said plurality of conductors and said one of ground or virtual ground; and

wherein the element length, a value of said at least one of said plurality of reactive tuning components and a value of each of said at least one inductive element for each of said plurality of conductors are set so an apparent electrical length of each of said plurality of conductors is equal to be about  $n\lambda/4$ , where  $n$  is an integer  $\geq 1$  and  $\lambda$  is the wavelength of the signal to be detected.

62. The system of claim 60, wherein said plurality of conductors are further arranged so as to form a cylindrical strip array in which each of the plurality of conductors extend along a cylinder axis thereof.

63. The system of claim 60, wherein said plurality of conductors are further arranged so as to form a cylindrical strip array in which each of the plurality of conductors extend circumferentially about a cylinder axis thereof.

64. The system of claim 63, wherein each circumferentially extending conductor is arranged so as to form a continuous loop.

65. The system of claim 60, wherein said strip array antenna is configured and arranged so as to form a flexible strip array antenna.

66. The system of claim 60 wherein at least the detection device is configured and arranged to detect hydrogen ( $^1\text{H}$ ) NMR signals.

- 76 -

67. The system of claim 60 wherein at least the detection device is configured and arranged to detect NMR signals from nuclei other than hydrogen.

68. A method of NMR comprising the steps of:  
placing a sample of interest in an NMR scanner,  
exciting NMR signal in at least one region of said sample;  
providing a detection device that detects NMR signals, said detection device comprising a strip array antenna that includes:  
a plurality of conductors being arranged so a long axis of each is in parallel and spaced from each other, each of the plurality of conductors having a length,  
a plurality of reactive tuning components, at least one of said plurality of reactive tuning components being electrically coupled to each conductor and to one of ground or virtual ground, and  
wherein the length of each conductor and a value of each reactive tuning component are set so an apparent electrical length of each conductor is equal to be about  $n\lambda/4$ , where  $n$  is an integer  $\geq 1$  and  $\lambda$  is the wavelength of the MR/ NMR signals to be detected; and  
detecting signals from said at least one region using said detection system.

69. A method of NMR comprising the steps of:  
placing a sample of interest in an NMR scanner,  
selectively exciting NMR signal in at least one region of said sample;  
providing a detection system that detects NMR signals, said detection system including a strip array antenna that includes:  
a plurality of conductors arranged so a long axis of each is in parallel and spaced from each other, wherein each of said plurality of conductors includes at least one conducting element having an element length,

- 77 -

a plurality of inductive elements at least one inductive element being electrically coupled to said at least one conducting element of each of said plurality of conductors, and

wherein the element length of said at least one conducting element, and a value of said at least one inductive element electrically coupled thereto are set so an apparent electrical length of each of said plurality of conductors is equal to be about  $n\lambda/4$ , where  $n$  is an integer  $\geq 1$  and  $\lambda$  is the wavelength of the signal to be detected; and detecting signals from said at least one region using said detection device.

70. A method for MRI comprising the steps of:  
putting a sample of interest in an imager of an MRI system;  
applying a transverse RF excitation field tuned to a resonant frequency in the sample;  
applying magnetic field gradients in at least one of the X, Y or Z directions so as to cause nuclei to be encoded according to their position in the sample;  
providing a detection system that detects MR signals, said detection system including a strip array antenna that includes:  
a plurality of conductors being arranged so a long axis of each is in parallel and spaced from each other, each of the plurality of conductors having a length,  
a plurality of reactive tuning components, at least one of said plurality of reactive tuning components being electrically coupled to each conductor and to one of ground or virtual ground, and  
wherein the length of each conductor and a value of each reactive tuning component are set so an apparent electrical length of each conductor is equal to be about  $n\lambda/4$ , where  $n$  is an integer  $\geq 1$  and  $\lambda$  is the wavelength of the MR/ NMR signals to be detected;  
detecting MR signals using said detection system; and  
processing the MR signals and reconstructing an image from the processed signals.

- 78 -

71. The MRI method of claim 68, further comprising the step of displaying the reconstructed image.

72. The MRI method of claim 69 wherein the detection system is used for parallel sensitivity encoding and wherein said processing and reconstructing includes generating images from said NMR signals using a parallel sensitivity encoding technique.

73. The MRI method of claim 70, wherein the sample of interest is a portion of a body.

74. The MRI method of claim 70, wherein said MRI system comprises a magnet, gradient magnetic field coil means, gradient coil supply means, RF transmit means, and gradient and RF control means.

75. A method for MRI comprising the steps of:  
putting a sample of interest in an imager of an MRI system;  
applying transverse RF excitation field tuned to a resonant frequency in the sample;  
applying magnetic field gradients in at least one of the X, Y or Z directions so as to cause nuclei to be encoded according to their position in the sample;  
providing a detection system that detects MR signals, said detection system including a strip array antenna that includes:  
a plurality of conductors arranged so a long axis of each is in parallel and spaced from each other, wherein each of said plurality of conductors includes at least one conducting element having an element length,  
a plurality of inductive elements at least one inductive element being electrically coupled to said at least one conducting element of each of said plurality of conductors, and



- 79 -

wherein the element length of said at least one conducting element, and a value of said at least one inductive element electrically coupled thereto are set so an apparent electrical length of each of said plurality of conductors is equal to be about  $n\lambda/4$ , where  $n$  is an integer  $\geq 1$  and  $\lambda$  is the wavelength of the signal to be detected; detecting MR signals using said detection system, and processing the MR signals and reconstructing an image from the processed signals.

76. The MRI method of claim 75, further comprising the step of displaying the reconstructed image.

77. The MRI method of claim 75 wherein the MRI system and the detection system are configured so as to be used for parallel sensitivity encoding and wherein said processing and reconstructing includes processing the MR signals and reconstructing an image from the processed signals using a parallel sensitivity encoding technique.

78. The MRI method of claim 75, wherein the sample of interest is a portion of a body.

79. The MRI method of claim 75, wherein said MRI system comprises a magnet, gradient magnetic field coil means, gradient coil supply means, RF transmit means, and gradient and RF control means.